

mon parasites of mammals and reptiles but do not occur as parasites in birds (Morgan, 1946). Roca (1993) suggested that the importance of lizards as prey can be ascertained by the prevalence of larval helminths in the lizard population. More work will be required to elucidate the life cycle of these encysted *Abbreviata* and to determine whether or not the anoles are prey items in any mammals of Bermuda.

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Literature Cited

- Baker, M. R.** 1987. Synopsis of the Nematoda parasitic in amphibians and reptiles. Memorial University of Newfoundland, Occasional Papers in Biology 11:1-325.
- Bundy, D. A. P., P. Vogel, and E. A. Harris.** 1987. Helminth parasites of Jamaican anoles (Reptilia: Iguanidae): a comparison of the helminth fauna of 6 *Anolis* species. *Journal of Helminthology* 61: 77-83.
- Coy Otero, A., and V. Barus.** 1979. Nematodes parasitizing Cuban reptiles. *Acta Scientiarum Naturalium Academiae Scientiarum Bohemoslovacae* Brno 13:1-43.
- Dobson, A. P., S. V. Pacala, J. D. Roughgarden, E. R. Carper, and E. A. Harris.** 1992. The parasites of *Anolis* lizards in the northern Lesser Antilles. I. Patterns of distribution and abundance. *Oecologia* 91:110-117.
- Goldberg, S. R., C. R. Bursey, and R. Tawil.** 1995. Gastrointestinal helminths of *Eleutherodactylus johnstonei* (Leptodactylidae) from Bermuda. *Journal of the Helminthological Society of Washington* 62:67-69.
- Morgan, B. B.** 1946. Host-parasite relationships and geographical distribution of the Physalopterinae (Nematoda). *Transactions of the Wisconsin Academy of Sciences and Letters* 38:273-292.
- Roca, V.** 1993. Methods and aims in parasitology of Mediterranean reptiles, mainly lizards. Pages 253-262 in E. D. Valakos, W. Böhme, V. Pérez-Mellado, and P. Maragou, eds. *Lacertids of the Mediterranean region. A Biological Approach*. Hellenic Zoological Society, Athens, Greece.
- Schwartz, A., and R. W. Henderson.** 1991. *Amphibians and Reptiles of the West Indies. Descriptions, Distributions and Natural History*. University of Florida Press, Gainesville. xvi + 720 pp.
- Skryabin, K. I., N. P. Shikhobalova, and A. A. Mozgovoi.** 1951. Key to Parasitic Nematodes. Vol. 2. Oxyurata and Ascaridata. *Akademiya Nauk SSSR Publishers*, Moscow. Translated from Russian and published for the U.S. Department of Agriculture and the National Science Foundation, Washington D.C., by Amerind Publishing Co. Pvt. Ltd., New Delhi, 1982. 703 pp.
- Wingate, D. B.** 1965. Terrestrial herpetofauna of Bermuda. *Herpetologica* 21:202-218.

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Research Note

Helminths of an Introduced Population of the Giant Toad, *Bufo marinus* (Anura: Bufonidae), from Bermuda

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ABSTRACT: Forty-five giant toads, *Bufo marinus*, from Bermuda were examined for helminths. Two nematode species were found: *Aplectana* sp. (87% prevalence) and *Rhabdias fuelleborni* (71% prevalence). One toad harbored the trematode *Mesocoelium monas* (2% prevalence). Bermuda represents a new distributional record for *M. monas* and *R. fuelleborni*.

KEY WORDS: Trematoda, *Mesocoelium monas*, Nematoda, *Aplectana* sp., *Rhabdias fuelleborni*, *Bufo marinus* (Bufonidae).

The giant toad, *Bufo marinus* (Linnaeus, 1758), originally ranged from southern Texas to central Brazil but has since been introduced into the Caribbean Islands, Hawaii, Fiji, Philippines, Taiwan, Ryukyu, New Guinea, Australia, and many Pacific islands (Frost, 1985). Specimens from Guiana were introduced into Bermuda about 1885 (Wingate, 1965). The purpose of this

note is to report the helminths harbored by *B. marinus* from Bermuda. Helminths infecting other populations of *B. marinus* have been summarized by Speare (1990).

Forty-five adult *B. marinus* (mean snout-vent length = $122.4 \text{ mm} \pm 2.5 \text{ SE}$, range 81–155) were hand-collected on the grounds of the Bermuda Biological Station for Research, St. George's Parish ($64^{\circ}42' \text{N}$, $32^{\circ}22' \text{W}$), Bermuda, 14–18 August 1992. The sample consisted of 27 males and 18 females. The toads were fixed in neutral-buffered 10% formalin. The body was opened by a longitudinal incision from throat to vent and the gastrointestinal tract was removed by cutting across the esophagus and rectum; the lungs, liver, and urinary bladder were also examined. Each organ was examined separately under a dissecting microscope. Helminths were placed on a glass slide in a drop of glycerol and covered with a coverslip. They were allowed to clear overnight before identification was attempted utilizing a compound microscope. Terminology usage is in accordance with Margolis et al. (1982). Selected helminths were deposited in the U.S. National Parasite Collection (USDA, Beltsville, Maryland): *Mesocoelium monas*, 83794; *Aplectana* sp., 83795; *Rhabdias fuelleborni* adults, 83796, *R. fuelleborni* larvae, 83797. All toads were deposited in the herpetology collection of the Natural History Museum of Los Angeles County, LACM 140191–140235.

Forty of 45 (89%) *B. marinus* harbored helminths: 24 of 27 males (89%), and 16 of 18 females (89%). The trematode *Mesocoelium monas* (Rudolphi, 1819) Freitas, 1958, was found in the small intestine of 1 female toad (prevalence 2%; intensity 23.0). *Aplectana* sp. (females only) were found in the small and large intestines of 39 toads (prevalence 87%, mean intensity = $20.6 \pm 4.3 \text{ SE}$, range 1–109, 802 nematodes); 23 males (85%) and 16 females (89%) were infected. *Rhabdias fuelleborni* Travassos, 1926 (larvae and hermaphroditic adults), were found in 32 toads (prevalence 71%, mean intensity = $9.1 \pm 2.5 \text{ SE}$, range 1–53, 291 nematodes). Of these, 26 toads (17 males, 65%; 9 females, 35%) harbored hermaphroditic adults in the lungs (prevalence 58%, mean intensity = $10.5 \pm 3.0 \text{ SE}$, range 1–52, 272 nematodes) and 9 toads (7 males, 26%; 2 females, 11%) had larvae in the stomach, small or large intestine (prevalence 20%, mean intensity = $2.1 \pm 5.1 \text{ SE}$, range 1–8, 19 nematodes). There was no significant difference in prevalence of infection by nematode species between male and fe-

male toads (*Aplectana* sp., chi-square = 0.01, 1 df, $P > 0.05$; *R. fuelleborni*, chi-square = 0.44, 1 df, $P > 0.05$).

Williams (1959) published the results of the only previous parasitological investigation of *B. marinus* from Bermuda. Thirty-three of 40 toads (83%) harbored *Rhabdias sphaerocephala* in the lungs; a maximum of 50 nematodes were found. Ten of 40 toads (25%) harbored *Aplectana velardi*; a maximum of 130 nematodes were found. Although we question the identity of the species, prevalence and maximum number for *Rhabdias* in these 2 reports are similar: 71% with a maximum of 53 (our study) versus 83% with a maximum of 50 (Williams, 1959). Prevalence of *Aplectana* in our study is more than triple that reported by Williams (1959); 87% compared to 25%; however, maximum numbers are similar: 109 (our study) compared to 130. Since *Rhabdias* and *Aplectana* are monoxenous, these differences may simply reflect the patchiness of infective larvae. Williams (1960) experimentally infected *B. marinus* with *Rhabdias* larvae recovered from fresh toad feces.

Species of *Rhabdias* are lung parasites of amphibians and reptiles (Anderson, 1992). Those previously reported from *Bufo marinus* include *R. fuelleborni*, Brazil (Kloss, 1971) and Guatemala (Caballero y C., 1954, = *B. horribilis*), and *R. sphaerocephala*, Mexico (Bravo H. and Caballero y C., 1940), Costa Rica (Brenes and Bravo Hollis, 1959), Bermuda (Williams, 1960), Jamaica (Colam, 1971), and Brazil and Paraguay (Kloss, 1971, 1974). Baker (1987) considers *R. sphaerocephala* to be a European species and that American records of its occurrence need confirmation. The species of *Rhabdias* in this study lack the anterior body wall swelling and cuticular inflation as well as the anterior esophageal swelling of *R. sphaerocephala* and is somewhat shorter. It best fits the description of *R. fuelleborni* as given by Travassos (1926a). This report represents a new distributional record for *R. fuelleborni*.

Forty nominal species of *Aplectana* occur as intestinal parasites of amphibians and reptiles (see Baker, 1987). Males are known for all of these species. Barus (1972) described 2 species of *Aplectana* from *Eleutherodactylus* spp. from Cuba. Males were not found for either species, but 1 was named *Aplectana cubana*; the other was not named. Because species identification in *Aplectana* cannot be determined in the absence of males, Baker (1987) considered *A. cubana* as

a species incertae sedis. Goldberg et al. (1995) reported a similar *Aplectana* sp. in *Eleutherodactylus johnstonei* from Bermuda; that is, males were absent. Individuals of *Aplectana* reported herein are larger (2.10–2.80 mm) than those from *Eleutherodactylus johnstonei* (1.70–2.00). However, when intensities in *B. marinus* are greater than 100 individuals, maximum *Aplectana* length is limited to about 2 mm. Individual nematodes from *B. marinus* frequently contained more eggs than did those from *E. johnstonei*. Otherwise, no morphological differences were noted in specimens of *Aplectana* from the 2 amphibian species. In both nematodes, the reproductive systems were didelphic and prodelphic; eggs were $63\text{--}74\text{ }\mu\text{m} \times 40\text{--}51\text{ }\mu\text{m}$ and in many cases contained a coiled larva. Most likely the same species of *Aplectana* infects both *B. marinus* and *E. johnstonei* in Bermuda. However, with the absence of males, species identification is not possible. Size differences are likely due either to crowding, a well-described phenomenon in helminths (Morgan, 1942), or related to size differences between the 2 hosts; our Bermuda *B. marinus* sample is approximately 5 times larger than our *E. johnstonei* sample (Goldberg et al., 1995). Other species of *Aplectana* have been reported from *B. marinus*: *A. hoffmanni* from Costa Rica (Brenes and Bravo Hollis, 1959); *A. incerta* from Mexico (Caballero y C., 1949); *A. itzocanensis* from Costa Rica by Brenes and Bravo Hollis (1959) and Mexico (Caballero Deloya, 1974); and *A. vellardi* from Brazil (Travassos, 1926b).

Freitas (1963) synonymized 19 species of the genus *Mesocoelium* from a wide variety of amphibians and reptiles with *M. monas*. The list of synonymized species was expanded to 23 by Nasir and Diaz (1971), who, in the process, recognized only 4 species. *Mesocoelium monas* has been recovered from *B. marinus* from widely separated geographical regions such as Brazil, Columbia, Costa Rica, Hawaii, Paraguay, Puerto Rico (Nasir and Diaz, 1971), Jamaica (Wong and Bundy, 1985), and American Samoa (Goldberg and Bursey, 1992). This is the first report of *M. monas* from the North Atlantic islands.

The herpetofauna of Bermuda is limited to 1 endemic skink, *Eumeces longirostris*, 3 introduced anoles, *Anolis bimaculatus leachi*, *A. grahami*, and *A. roquet*, and 2 eleutherodactylid frogs, *Eleutherodactylus gossei* and *E. johnstonei* and *B. marinus* (Wingate, 1965). Whether the helminths of Bermuda *B. marinus* were acquired

from contact with sympatric herptiles or may have been present in the introduced toads is not known.

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Literature Cited

- Anderson, R. C. 1992. Nematode Parasites of Vertebrates. Their Development and Transmission. CAB International, Wallingford, Oxon, U.K. 578 pp.
- Baker, M. R. 1987. Synopsis of the Nematoda parasitic in amphibians and reptiles. Memorial University of Newfoundland Occasional Papers in Biology 11:1–325.
- Barus, V. 1972. Nematodes parasitizing hosts of the genus *Eleutherodactylus* (Amphibia) from Cuba. Vestník Československé Společnosti Zoologické 36:161–168.
- Bravo, Hollis, M., and E. Caballero C. 1940. Nematodos parásitos de los batracios de México. IV. Anales del Instituto de Biología Universidad Nacional de México 11:239–247.
- Brenes, R. R., and M. Bravo Hollis. 1959. Helmintos de la República de Costa Rica. VIII. Nematoda 2. Algunos nemátodos de *Bufo marinus marinus* L. y algunas consideraciones sobre los géneros *Oxytomatum* y *Aplectana*. Revista de Biología Tropical 7:35–55.
- Caballero y C., E. 1949. Estudios helmintológicos de la región oncocercosa de México y de la República de Guatemala. Nematoda, 5 Parte. Anales del Instituto de Biología Universidad Nacional de México 20:279–292.
- . 1954. Estudios helmintológicos de la región oncocercosa de México y de la República de Guatemala. Nematoda, 8 Parte. Anales del Instituto de Biología Universidad Nacional de México 25:259–274.
- Caballero Deloya, J. 1974. Estudio helmintológico de los animales silvestres de la estación de biología tropical “Los Tuxtlas,” Veracruz. Nematoda I. Algunos nemátodos parásitos de *Bufo horribilis* Wiegmann, 1833. Anales del Instituto de Biología Universidad Nacional de México 45:45–50.
- Colam, J. B. 1971. Studies on gut ultrastructure and digestive physiology in *Rhabdias bufonis* and *R. sphaerocephala* (Nematoda: Rhabditida). Parasitology 62:247–258.
- Freitas, J. R. T. 1963. Revisão da família Mesocoeliidae Dollfus, 1933 (Trematoda). Memórias do Instituto Oswaldo Cruz 61:177–311.
- Frost, D. R., ed. 1985. Amphibian Species of the World. A Taxonomic and Geographic Reference. Allen Press, and Association of Systematic Collections, Lawrence, Kansas. 732 pp.
- Goldberg, S. R., and C. R. Bursey. 1992. Helminths of the marine toad, *Bufo marinus* (Anura: Bufon-

- idae), from American Samoa. *Journal of the Helminthological Society of Washington* 59:131–133.
- , and R. Tawil. 1995. Gastrointestinal helminths of *Eleutherodactylus johnstonei* (Leptodactylidae) from Bermuda. *Journal of the Helminthological Society of Washington*. (In press.)
- Kloss, G. R. 1971. Alguns *Rhabdias* (Nematoda) de *Bufo* no Brasil. *Papéis Avulsos de Zoologia* 24:1–52.
- . 1974. *Rhabdias* (Nematoda, Rhabditoidea) from the *marinus* group of *Bufo*. A study of sibling species. *Arquivos de Zoologia* 25:61–120.
- Margolis, L., G. W. Esch, J. C. Holmes, A. M. Kuris, and G. A. Schad. 1982. The use of ecological terms in parasitology (report of an ad hoc committee of the American Society of Parasitologists). *Journal of Parasitology* 68:131–133.
- Morgan, B. B. 1942. The nematode genus *Skrjabinoptera* Schulz, 1927. *Lloydia* 5:314–319.
- Nasir, P., and M. T. Diaz. 1971. A redescription of *Mesocoelium monas* (Rudolphi, 1819) Freitas, 1958, and specific determination in genus *Mesocoelium* Odhner, 1910 (Trematoda, Digenea). *Revista di Parassitologia* 32:149–158.
- Speare, R. 1990. A review of the diseases of the cane toad, *Bufo marinus*, with comments on biological control. *Australian Wildlife Research* 17:387–410.
- Travassos, L. 1926a. Entwicklung des *Rhabdias fuelleborni* n. sp. *Deutsche Tropenmedizinische Zeitschrift* 30:594–602.
- . 1926b. Sôbre uma nova *Aplectana*. *Boletim Biologico* 3:45–48.
- Williams, R. W. 1959. Some nematode parasites of tree frogs, toads, lizards and land crabs of the Bermuda Islands. *Journal of Parasitology* 45:239.
- . 1960. Observations on the life history of *Rhabdias sphaerocephala* Goodey, 1924 from *Bufo marinus* L., in the Bermuda Islands. *Journal of Helminthology* 34:93–98.
- Wingate, D. B. 1965. Terrestrial herpetofauna of Bermuda. *Herpetologica* 21:202–218.
- Wong, M. S., and D. A. P. Bundy. 1985. Population distribution of *Ochoterella digiticauda* (Nematoda: Onchocercidae) and *Mesocoelium monas* (Digenea: Brachycoeliidae) in naturally infected *Bufo marinus* (Amphibia: Bufonidae) from Jamaica. *Parasitology* 90:457–461.

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Research Note

Gastrointestinal Helminths of *Eleutherodactylus johnstonei* (Leptodactylidae) from Bermuda

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ABSTRACT: Eighty-four leptodactylid frogs, *Eleutherodactylus johnstonei*, were collected in August 1992 from St. George's Parish, Bermuda, and examined for gastrointestinal helminths. Forty-five (54%) harbored 1 or more species of nematode: 18 with *Aplectana* sp. (21% prevalence, mean intensity 6.6 ± 2.2 SE), 25 with *Parapharyngodon garciae* (30%, 1.5 ± 0.2 SE), and 3 with larval physalopterans (4%, 1.7 ± 0.7 SE). *Eleutherodactylus johnstonei* represents a new host record for each of these species of nematodes.

KEY WORDS: Nematoda, *Aplectana* sp., *Parapharyngodon garciae*, physalopteran larvae, *Eleutherodactylus johnstonei*, Leptodactylidae.

The leptodactylid frog, *Eleutherodactylus johnstonei* Barbour, 1914, is known from Anguilla, Antigua, Barbados, Barbuda, Grenada, Guadeloupe, Jamaica, Montserrat, Nevis, Saba,

St. Barthélemy, St. Christopher, St. Eustatius, St. Lucia, St. Martin, and St. Vincent and is found from sea level to 853 m (Schwartz and Henderson, 1991) on these Caribbean islands. *Eleutherodactylus johnstonei* was accidentally introduced into Bermuda, probably from Jamaica, about 1886 (Pope, 1917). To our knowledge, there are no previous reports of helminths from this frog. The purpose of this report is to report the gastrointestinal helminths of *E. johnstonei* from Bermuda.

Eighty-four *E. johnstonei* (mean snout–vent length = $24.6 \text{ mm} \pm 0.4$ SE, range 11–31) were hand-collected on the grounds of the Bermuda Biological Station for Research, St. George's Parish ($64^{\circ}42'N$, $32^{\circ}22'W$), Bermuda, 14–18 August